

PROJECT FACT SHEET

CONTRACT TITLE: Research Program on Fractured Petroleum Reservoirs

ID NUMBER: DE-FG26-99BC15177

B&R CODE: AC1005000

CONTRACTOR: Reservoir Engineering Research Institute

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PROJECT SITE

CITY: Palo Alto

STATE: CA

CITY:

STATE:

CITY:

STATE:

CONTRACT PERFORMANCE PERIOD:

3/31/1999 to 3/30/2002

PROGRAM: Supporting Research

RESEARCH AREA: Extraction Research

PRODUCT LINE: ADIS

FUNDING (1000'S)	DOE	CONTRACTOR	TOTAL
PRIOR FISCAL YRS	0	0	0
FISCAL YR 1999	100	500	600
FUTURE FUNDS	200	0	200
TOTAL EST'D FUNDS	300	500	800

OBJECTIVE: Continued research in the area of fractured petroleum reservoirs.

PROJECT DESCRIPTION:

Background: This work is a continuation of DE-FG22-96BC14850.

Work to be Performed: The objectives of this project are to achieve five tasks: 1) Theoretical estimation of fracture compressibility and fracture permeability, 2) Wettability alteration in gas condensate reservoirs and gas mobility in heavy oil reservoirs, 3) Characterization of fractured reservoirs from PVT samples, 4) Water injection in fractured porous media, and 5) Characterization of natural fractures in naturally fractured reservoirs. The study based on each of these tasks will include an analytical or experimental phase which will be conducted in conjunction with the theoretical research.

PROJECT STATUS:

Current Work: In the first six months of this three-year program, four of the five tasks of the project have been very active. Task 1 - the estimation of fracture compressibility from the potential variations of the moon and the sun has been completed. Work has begun on the estimation of effective fracture and matrix permeability from tidal variations. There seems to be a lot of theoretical challenge on this aspect of Task 1.

Task 2 - comprised of two subtasks, 2a and 2b; cover the subject of gas wetting in application to gas condensate reservoirs and solution-gas drive in heavy oil reservoirs. Both subtasks are active. They have recently demonstrated that the efficiency of solution-gas drive in heavy oil reservoirs is not due to foamy nature of crude based on a number of carefully-conducted experiments. Relative permeability measurements on gas-wetting systems is also in progress.

Task 3 - covers the subject of diffusion and convection in fracture and unfractured media. Advanced concepts of irreversible thermodynamics are used to analyze PVT samples from hydrocarbon reservoirs. This task is very active with a very high level of industry interest. In the six-month period they have been primarily working on two-phase aspects of the project. A very interesting field example from Japan has been the focus of the task. In a large Japanese fractured gas condensate reservoir, the fluid becomes heaviest at the top. The RERI theoretical model can explain and predict this unusual behavior.

Task 4 - has focused on water injection in both water-wet and mixed-wet fractured reservoirs. They have carried out an extensive set of laboratory measurements with very unique results. The goal of the project is to show that laboratory measurements may provide a false impression of the results of water injection in fractured reservoirs. They are currently working on a different interpretation of laboratory results. This task has also been very active in this period.

Task 5 - They have just begun the work on characterization of natural fractures in naturally fractured reservoirs. The focus here will be discrete fractures, its descriptive and its modeling for multiphase flow.

Scheduled Milestones:

Design and build a special coreholder for use in experiments on gas-wetting in gas condensate systems	Cmpltd
Develop a very elaborate algorithm for calculating composition variation in fractured reservoirs and the effect of permeability on compositional variation	03/00

Accomplishments: In addition to papers presented at the 1999 SPE Fall Meeting, recent accomplishments include: Task 1 B A paper has been submitted to SPE Reservoir Evaluation and Engineering:

- Chang, E. and Firoozabadi, A.: A Gravitational Potential Variations of the Sun and Moon for the Estimation of Compressibility (of a Fractured Reservoir); SPE Reservoir Evaluation and Engineering.

An independent oil company in Houston provided tidal data on several wells. The data was analyzed and provided to the independent with compressibility and an estimate of permeability. The independent oil company was very impressed by the results of the model.

Task 2 B The following SPE paper was prepared and submitted for publication for subtask 2a.

- Tang, T. and Firoozabadi, A.: A Gas and Liquid-Phase Relative Permeabilities for Cold Production from Heavy Oil Reservoirs; SPE Reservoir Evaluation and Engineering.

Task 2 - The following two papers are scheduled for publication in SPE for subtask 2b:

- Li, K. and Firoozabadi, A.: An Experimental Study of Wettability Alteration to Preferential Gas-Wetting in Porous Media and Its Effects, SPE Reservoir Evaluation and Engineering (to be published).

- Li, K. and Firoozabadi, A.: A Phenomenological Modeling of Critical Condensate Saturation and Relative Permeabilities in Gas Condensate Systems, SPE Journal(to be published).

In addition, in the December issue of Reservoir Evaluation and Engineering, a paper on the subject Task 2b will be published. The work on both subtasks is of interest to most of the major oil companies. There is also a strong interaction with many oil company members.

Task 3 B A model based on irreversible thermodynamics has been developed. This model was successfully applied to predict the compositional variation in three reservoirs, one fractured, and two unfractured with excellent results. An SPE paper will be presented in Japan in April 2000. Two other SPE papers were also revised for publication in SPE Journal. Recently we received an invitation to give a graduate seminar at MIT for chemical engineering faculty and graduate students on theoretical aspects of this task.

Task 4 B The material of task 4 from the first six months of the work will be presented at the SPE/DOE meeting in Tulsa, April 2000. The focus of the work is viscous effect on water injection in mixed-wet fractured media. There are major findings in the work which is scheduled for presentation at the SPE/DOE meeting in Tulsa.

Task 5 B They have just begun working on this task.

In addition to publication of some 10 papers in top rated journals, they have been invited to give seminars at various research universities in the US and abroad (Norway, Australia, and England) and many different oil companies.